ATLAS Physics

ATLAS and the LHC

ATLAS has begun observing the dramatic head-on collisions of pairs of protons whose total energy is 7 TeV (3.5+3.5 TeV). In later years, the total energy will increase toward 14 TeV. The protons are accelerated to these high energies by the Large Hadron Collider (LHC) – an underground accelerator ring 27km in circumference. The LHC is filled with superconducting magnets to steer and focus the protons in beams that repeatedly circle the ring. The ambitious experimental programme of ATLAS will shed light on many unanswered questions about the origins of matter and the fundamental forces of nature.

The particle collisions

Measuring 46m long and 25m high, the ATLAS detector is the largest and one of the most elaborate particle physics experiments ever designed. The head-on collisions of protons at its centre leave debris that will reveal new particles and new processes in the interior of matter.

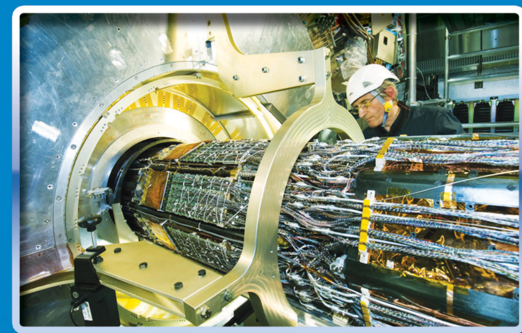
Various layers of the detector track the trajectories of the charged particles and measure the energies of most charged and neutral particles. The curvature of particle tracks in the magnetic field allows the momentum and electric charges to be determined. Out of nearly 1000 million collisions each second, only a few have the special characteristics that might lead to new discoveries. The trigger system selects such events for recording and avoids storing immense amounts of unnecessary information.

Detector

The ATLAS detector consists of four major components:

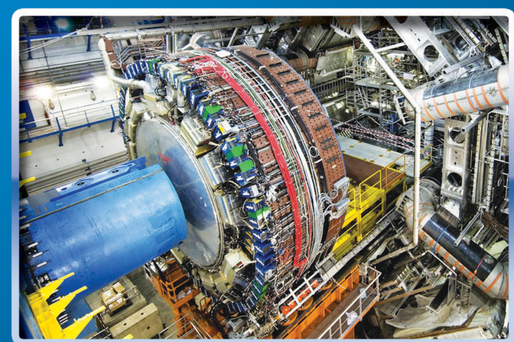
Inner Detector

Measures the momentum of each charged particle.



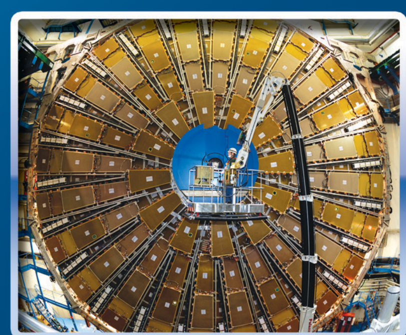
Calorimeters

Measure the energies carried by the particles.



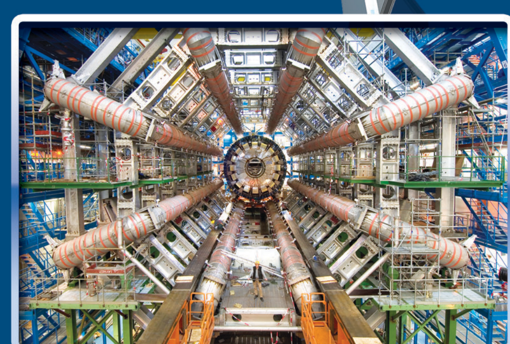
Muon Spectrometer

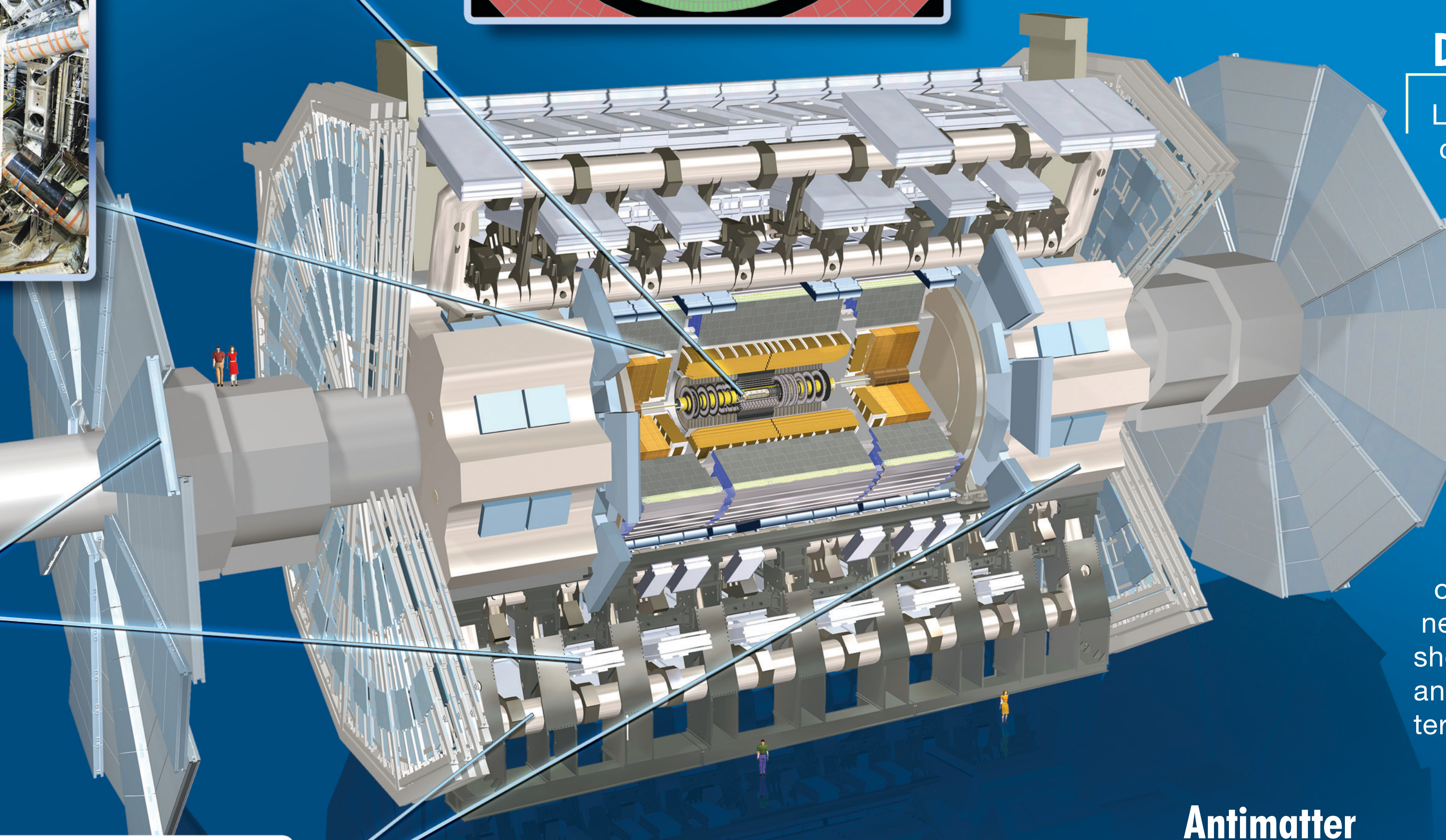
Identifies and measures the momenta of muons.



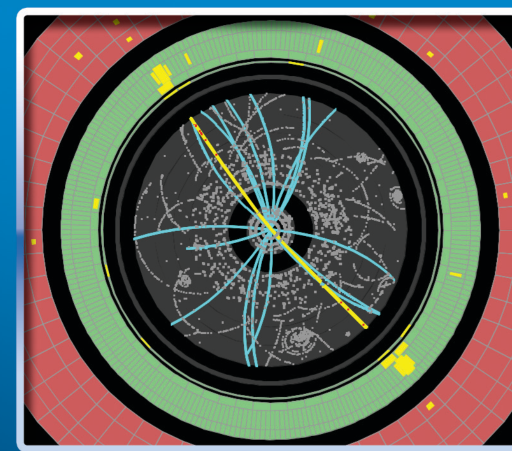
Magnet System

Bends charged particles for momentum measurement. The solenoid magnet surrounds the inner detector. Arrows point to toroid magnets.





The particles from a collision event leave tracks and deposit energy in the detector. Shown below is the first event in ATLAS of a Z boson decaying to electron and anti-electron.



The unknown

ATLAS brings experimental physics into new territory. Most exciting is the completely unknown surprise – new processes and particles that would change our understanding of energy and matter. ATLAS will learn about the basic forces that have shaped our universe since the beginning of time and that will determine its fate. Among the possible unknowns are extra dimensions of space, unification of fundamental forces, and evidence for string theory.

Dark matter

LHC recreates the conditions of the universe just after the Big Bang to understand why the universe is like it is today. ATLAS will investigate why the matter of the universe is dominated by an unknown type called dark matter. If the constituents of dark matter are new particles, ATLAS should discover them and elucidate the mystery of dark matter.

Mass

Why do fundamental particles have such different masses? Two of the greatest mysteries are how particles gain mass and how mass and energy are related. To explain these mysteries, theories predict a new particle, the Higgs particle. If this particle exists, ATLAS will discover it and provide great insight into the problem of masses.

Antimatter

At the very beginning of the universe, equal amounts of matter and antimatter existed. If matter and antimatter were exact mirror images of each other, they would have completely annihilated to leave only energy. But why was some of the matter left over to create galaxies, the solar system with our beautiful planet, and us? ATLAS will explore the tiny difference that exists between matter and antimatter.